

northeastward with increasing intensity to Minnesota. This disturbance was attended by snow or rain in all portions of the district, although the precipitation was light in southern New Mexico and southern Arizona and was followed by a cold wave in central Arizona, northeastern New Mexico, and southeastern Colorado.

On the morning of the 4th, when the storm was central over southeastern Colorado, violent local storms occurred in the eastern portion of the State. A tornado that appears to have originated 5 or 6 miles south of Sugar City, in Otero County, moved northward and northeastward through Lincoln, Washington, Yuma, and Phillips Counties, disappearing about 5 miles northeast of Amherst. Three persons were reported to have been killed outright and 10 injured, 2 so seriously that they died the following day. The total property loss was in excess of \$130,000.

Warning of a moderate cold wave was issued on the morning of the 4th for south-central and extreme eastern Colorado and southern and extreme eastern New Mexico. On account of the slow northeastward movement of the storm, the verifying limit was not reached in the portions of Colorado mentioned until the morning of the 6th. The fall in temperature in 24 hours amounted to more than 20° in most of eastern New Mexico, but the verifying limit was not quite reached in the southeastern portion of that State.

Another storm that appeared on the north Pacific coast on the 5th moved slowly southeastward to central California and western Nevada by the morning of the 9th and had overspread the northern Rocky Mountain States and the upper Missouri Valley on the 10th. During the 10th this disturbance formed a trough of pressure that extended from the southern Rocky Mountain States to the northwestern portion of the Lake region, with separate centers over eastern New Mexico and southern Minnesota, while a high of considerable intensity developed over Montana. Snow or rain occurred in Utah, northern Arizona, and Colorado between the 9th and 12th, with heavy snow in north-central Colorado on the 11th.

On the morning of the 11th warning of a moderate cold wave was issued for southeastern and extreme eastern New Mexico, and on the evening of that date the same warning was distributed for southeastern Colorado. The warning was fully verified in northwestern New Mexico and southeastern Colorado. While a fall of 18° occurred in extreme southeastern New Mexico during the 24 hours ending at 8 p. m. of the 12th, the limit required for a complete verification was not reached until the following morning, when the coldest weather of the season occurred on the southeastern slope, the temperature falling to 2° at Denver, 6° at Pueblo, and 18° at Roswell.

Light rain in southern New Mexico on the 16th and light snow in northern New Mexico and Colorado on the 16th and 17th attended a moderate low which moved from northern Arizona to eastern Colorado on those dates.

Rain again occurred in southern New Mexico on the 21st, 22d, and 23d, and snow fell in northern New Mexico and southern and western Colorado from the 21st to the 24th, due to a most unusual storm which appeared over southwestern Arizona on the 19th and continued over that State and southern California until the 24th, without advancing eastward, a high in the meantime covering the sections to the northward and eastward.

The last storm of the month was a secondary disturbance which began to develop over Nevada on the 27th and remained nearly stationary, increasing in intensity until the 29th, after which it moved rapidly northeastward, its center having advanced to northwestern Nebraska on the

morning of the 30th. From the 28th to the 30th precipitation occurred in about all portions of the Denver district.

On the morning of the 29th live stock warnings were issued for western Colorado, extreme northwestern New Mexico, northeastern Arizona, and southeastern Utah, on account of the heavy snow and colder weather indicated for those sections. Heavy snow occurred over all of the area specified on the 29th and 30th, except in extreme northwestern Colorado, with lower though not severely cold temperatures.

Warning of a moderate cold wave was issued on the morning of the 30th for eastern Colorado and southwestern Utah. The warning was fully verified in most of eastern Colorado, but failed of verification in southwestern Utah, where a rapid increase in pressure was not attended by the usual fall in temperature.

No warning was issued in advance of the cold wave which occurred in central Arizona on the 4th. Moderate cold waves without warning also occurred in north-central Colorado on the 11th and 19th.

Freezing temperature was forecast on the morning of the 4th for south-central and southeast Arizona, with killing frost in the extreme southwest portion. On the following morning the minimum temperatures at Phoenix and Yuma were 34° and 38°, respectively, with killing frost at the former station. Frost warnings were also issued for south-central and southeast Arizona on the 6th, 10th, 12th, 18th, 19th, 24th, 25th, 26th, and 27th; for southern Arizona on the 5th, 11th, 13th, 14th, 16th, 17th, 21st, 22d, and 30th, and for south-central Arizona on the 20th and 23d. These warnings were generally verified by the occurrence of frost or frost temperatures, except those of the 27th and 30th.

Heavy to killing frost, without warning, occurred in southwestern Arizona on the 4th, and light frost in south-central Arizona on the 8th.—*J. M. Sherrier.*

SAN FRANCISCO FORECAST DISTRICT.

A large storm appeared over Alaska on the 1st and moved slowly southeastward, with its center several hundred miles at sea, and paralleling the coast until the 9th, when it curved eastward and passed inland over northern California. It gave rain or snow over the entire district from the 6th to the 10th. Another storm from the North Pacific moved inland through British Columbia and caused rain or snow over the North Pacific States on the 16th and 17th. A third storm moved inland through British Columbia giving rain or snow in the north Pacific States on the 27th and 28th. A secondary from this storm formed over the southern Plateau and gave rain in southern California and snow in Nevada on the 29th and 30th.

Storm warnings were ordered as follows: At North Pacific stations on the 3d, 5th, 6th, 15th, 17th, 18th, 21st, and 25th; on the northern California coast on the 6th, and on the southern California coast on the 9th. Advisory warnings were sent to North Pacific stations on the 20th. These warnings were generally verified and are believed to have been justified in all cases.—*G. H. Willson.*

RIVERS AND FLOODS.

By H. C. FRANKENFIELD, Meteorologist.

A further deficiency in rainfall during the month of November over the eastern portion of the country accented an already serious drought situation. Stream flow decreased materially, and in many communities

the supply of water for domestic, agricultural, and commercial purposes was reduced to a dangerous minimum. The situation was especially grave in Pennsylvania, New York, and Maryland, and at the close of the month there was no prospect of early relief.

There were minor floods in the Grand River of Missouri and in Chisholm Creek, a tributary of the Arkansas River, in the vicinity of Wichita, Kans. The flood in the Grand River was caused by heavy rains on November 11 and 12, over south-central Iowa and northern Missouri, and the river at Chillicothe, Mo., rose from 5.9 feet on November 12 to 26.2 feet on November 18, flood stage being at 18 feet. Warnings for a stage of 21 feet were issued on November 13, failure to forecast the higher stage reached having been due to absence of precipitation data from the Iowa portion of the drainage area. The rise came from both branches of the river, but there was no damage of consequence, as the great flood of July, 1922, left nothing more subject to damage from overflow.

The flood in Chisholm Creek, Kans., was due to the same general rain storm, Wichita, Kans., reporting 4.20 inches in 24 hours. The flood waters came entirely from Chisholm Creek, and nearly 3 square miles of North Wichita were covered with water. While the inconvenience caused was great, the damage was slight. As there are no reporting stations on Chisholm Creek, it was impossible to issue warnings of the flood.

The new canal in the Mississippi River at Le Claire, Iowa, was opened for business about the end of the month. The pool formed by the construction of the necessary dam has eliminated the Rock Island Rapids, which in the past have proved a great hindrance to navigation. The canal begins at the upper end of the Rock Island Rapids, just below Le Claire and extends downstream, roughly paralleling the Iowa shore, and Smiths Island was used as a portion of the eastern bank. The total length of the improvement is about $3\frac{1}{2}$ miles.

Flood stages during November, 1922.

River and station.	Flood stage.	Above flood stages—dates.		Crest.	
		From—	To—	Stage.	Date.
MISSISSIPPI DRAINAGE.					
Grand: Chillicothe, Mo.....	<i>Fect.</i> 18	14	19	<i>Fect.</i> 26.2	18

MEAN LAKE LEVELS DURING NOVEMBER, 1922.

By UNITED STATES LAKE SURVEY.

[Detroit, Mich., Dec. 5, 1922.]

The following data are reported in the "Notice to Mariners" of the above date:

Data.	Lakes. ¹			
	Superior.	Michigan and Huron.	Erie.	Ontario.
Mean level during November, 1922: Above mean sea level at New York.	<i>Fect.</i> 602.35	<i>Fect.</i> 579.54	<i>Fect.</i> 571.41	<i>Fect.</i> 245.15
Above or below—				
Mean stage of October, 1922.	-0.15	-0.43	-0.45	-0.46
Mean stage of November, 1921.	+0.15	-0.10	-0.39	+0.30
Average stage for November, last 10 years.	-0.25	-0.81	-0.57	-0.51
Highest recorded November stage.	-1.16	-3.38	-2.26	-2.67
Lowest recorded November stage.	+0.35	+0.36	+0.71	+1.74
Average relation of the November level to—				
October level.		-0.20	-0.20	-0.20
December level.		+0.20	+0.20	+0.20

¹ Lake St. Clair's level: In November, 574.21 feet.

INFLUENCE OF WEATHER ON CROPS AND FARMING OPERATIONS—NOVEMBER, 1922.

By J. WARREN SMITH, Meteorologist.

November, 1922, was mild for the season in all sections east of the Rocky Mountains, especially from the central Mississippi Valley and central Plains States northward, where the temperature averaged from 4° to 7° above the normal. The first half of the month was cold, however, west of the Rocky Mountains, and the temperature for the month as a whole averaged below normal in that section. The drought conditions that had prevailed between the Mississippi Valley and the Rocky Mountains were relieved or broken early in the month by copious rains, and rainfall about the middle of the month was beneficial in the central Mississippi and the Ohio Valley States. The severe droughty conditions continued, however, throughout the month in most of the middle Atlantic coast section, particularly in much of Pennsylvania, New Jersey, and New York, where streams and wells were reported to be very low and stock water scarce.

Winter grains were greatly benefited by rainfall in the central trans-Mississippi States during the first week in the month, particularly in Kansas, where the best rains in three months occurred. The soil was put in good condition also in Oklahoma, and the seeding of wheat was resumed in that State. Good rains fell in much of the Ohio Valley area during the week ending November 21, which was helpful to winter wheat, particularly in Kentucky. Wheat showed substantial improvement in that area during the latter half of the month and at its close was in mostly good condition to go into the winter. Snowfall the latter part of the month in the far northwestern States was beneficial, although moisture continued insufficient in many sections of that area. Winter cereals needed moisture throughout most of the South.

The mild, dry weather during the first half of the month in the South Atlantic States was favorable for maturing late corn in that section, and conditions were generally favorable for husking and cribbing from the Ohio Valley eastward. Fields were too wet for gathering corn in parts of Iowa and husking made slow progress during much of the month, while there was some damage to corn that had been blown down. The weather was mild and pleasant in much of the interior of the country during the latter part of the month and gathering corn, where not completed, made good progress in most sections.

Conditions were favorable for maturing and harvesting late cotton in the northeastern cotton growing districts but unusually early killing frosts did some damage to this crop in Arizona during the first week of the month. Some top crop matured in Texas. At the close of the month some cotton was still in the fields in the northeastern portion of the belt, but harvest was mostly completed elsewhere.

Truck crops were benefited by rains early in the month in parts of Texas, but moisture continued deficient from the lower Mississippi Valley northeastward to the Middle Atlantic States.

There was improvement in soil conditions in southern Florida, where it had been too wet. It was too warm in Louisiana for the best development of sugar cane, although the lower temperatures the latter part of the month were favorable.

There was sufficient moisture the first half of the month to improve ranges in the West, except in New Mexico, western Texas, and northeastern Arizona, but the continued dry weather in the eastern States was